Day Beds, Natal Dens, and Activity of Florida Panthers

David S. Maehr, *Florida Game and Fresh Water Fish Commission, 566 Commercial Blvd., Naples, FL 33942*

E. Darrell Land, *Florida Game and Fresh Water Fish Commission, 566 Commercial Blvd., Naples, FL 33942*

Jayde C. Roof, *Florida Game and Fresh Water Fish Commission, 566 Commercial Blvd., Naples, FL 33942*

J. Walter McCown, *Florida Game and Fresh Water Fish Commission, 566 Commercial Blvd., Naples, FL 33942*

Abstract: Day rest sites and natal dens of Florida panthers (*Felis concolor coryi*) studied from January 1986 to August 1989 were dominated by dense vegetation, especially saw palmetto (*Serenoa repens*). Activity peaked around sunrise and sunset for both denning females and solitary panthers; however, solitary panthers exhibited greater extremes in activity and inactivity. Females were most likely to be at the den during daylight and spent about 50% of the denning period at the den. Day beds and den sites are important habitat features and should be considerations in panther management.

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Recent telemetry studies of mountain lions have focused on general patterns of habitat use and movements (Hemker et al. 1984, Logan and Irwin 1985, Van Dyke et al. 1986, Belden et al. 1988). Little information exists concerning maternal dens (Maehr et al. 1989*a*), day bed characteristics, and behavior at these sites. In light of dwindling numbers of Florida panthers and the paucity of information on panther resting and denning habitat, studies of these aspects of its ecology are needed. This information is important in designing management actions for recovery of the Florida panther and could be compared with habitat and behavior profiles of other felids. We describe day beds and maternal dens and report on the behavior of Florida panthers at these sites.

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Methods

Study Area

Southwest Florida maintains a remnant population of 30–50 panthers in a fragmented, forested landscape of nearly 900,000 ha (Maehr 1990). This study was conducted in Collier and Hendry counties, Florida, including the Big Cypress National Preserve (Bear Island Unit), the Florida Panther National Wildlife Refuge, and adjacent private lands. The topography is flat with changes in vegetation resulting from minor variations in drainage patterns and soils. Major vegetation associations include hardwood hammocks, cypress forests, pine flatwoods, cabbage palm forests, mixed swamps (Davis 1943), and agricultural types including improved pasture, citrus, and vegetable crops. Climate is tropical savannah, mean annual temperature is 23 C (Deuver et al. 1986), and mean annual rainfall is 1,400–1,525 mm.

Habitat and Activity

During our searches for kills made by radio-instrumented panthers, many panther day beds were found. We made ocular estimates of bed dimensions and dominant horizontal cover and recorded associated plant species and temperature. Dominance was determined by ocular estimation of the plant or structure providing $> 50\%$ of the horizontal cover within 3 m of the day use site. Day beds were confirmed by locating the bed depression, noting the presence of recently-shed panther hair, and occasionally sighting resting radio-collared panthers. Parturition dates of radio-collared adult females were determined from known associations with radio-collared adult males and behavioral changes occurring after a 90–96 day gestation (Maehr et al. 1989*a*). We monitored adult female presence at den sites throughout the denning period using automatic field data recording stations for each female. We defined denning as the period of kitten immobility from parturition to den abandonment. Pulse rate changes of motion-sensitive transmitters attached to adult male and female panthers were recorded with a digitized data processor, receiver (TDP–2, TR–2; Telonics, Inc., Mesa, Ariz.), and chart recorder (Gulton Co., mod. 2W288, Manchester, N.H.). Solitary panther activity data were collected with the above equipment mounted on off-road vehicles. Solitary panthers were subadult males, adult males or females without kittens. Radio transmitters (Mod. 500, Telonics, Inc.) were equipped with motion-sensitive switches and variable pulse rates (about 70 pulses/minute [ppm] with head up and 60 ppm head down). Activity rate was recorded as the percentage of minutes within each hour containing a pulse change. Details of panther capture techniques can be found in Maehr et al. (1989*a*) and McCown et al. (1990).

Activity Data Analysis

Hourly activity percentages were averaged for each panther over all days of monitoring. Panther*hour means were assumed to arise from a split-plot arrangement of treatments, where denning females and solitary panthers formed 2 levels of a whole plot group treatment and 24 hours comprised the subplot treatment (Steel and Torrie 1980:377–400). The group*hour effect provided a comparison of diurnal activity patterns between denning and solitary panthers. A sinusoidal contrast incorporating period cycles of 12 and 24 hours was fit to each of the hour and group*hour least squares means. Degree of similarity for each contrast was estimated by subtracting the sum of squares for the contrast from the sum of squares for the parent effect. The sinusoidal contrast for the group*hour effect was separated into single degree of freedom contrasts to identify differences between denning and solitary panther activity pattern amplitudes and phases. Panther*hour means were square root-transformed (Steel and Torrie 1980:234–235).

Results and Discussion

We searched around 178 day beds of 18 different panthers from January 1986 through August 1989. Ninety-five beds were located and described (Table 1). Beds were slight depressions in bare earth or dried leaves and were ovoid, measuring <0.5–1.0 m wide × 1.0–2.0 m long. Vegetation usually provided a vertical canopy and blocked horizontal vision of investigators from beyond 2 m of the bed. Saw palmetto was the dominant vegetation at 66% of the beds. Other important cover included blechenum fern (*Blechenum serrulatum*), cabbage palm (*Sabal palmetto*), limestone solution holes, and tree root bases. Upland vegetation was used as cover 75% of the time. Two of 6 maternal den sites were previously described by Maehr et al. (1989*a*). Saw palmetto was the dominant cover at 4 dens, and 2 dens were located in dense shrubs (*Myrica cerifera, Cornus foemina*) and vines (*Smilax* spp., *Vitis* spp.) within live oak hammocks. Den sites were similar to day beds but contained evidence of kitten activity (i.e. clawed bark, chewed vegetation, and matted leaves). Three sites had multiple dens (within a 50 m radius).

Five solitary panthers (2 adult males, 2 adult females, 1 subadult male) were monitored continuously for 130 hours during spring, summer, and winter, 1986–1989. Reduced activity occurred between sunrise and sunset (Fig. 1). Peaks in activity occurred at sunrise and 0–2 hours after sunset. The greatest variation in activity occurred at night. We rarely observed measurable shifts in panther location during the day, while nocturnal shifts in location exceeding 20 km were not unusual and the highest levels of activity occurred at night (Fig. 1). Therefore, day beds were temporally the most important habitat feature used by panthers.

Four females at dens were monitored for a combined 4,624 continuous hours during the first 2 months post-partum. These denning females were most likely to be found at the den between 0800 and 1600 (Fig. 2). Presence at the den of these females ranged from 45.0% to 54.2% ($\bar{x}$ = 50.2) of the denning period (Fig. 3);

Table 1. Composition of 95 Florida panther day use sites, South Florida, 1986–89. Listed species occur at least once as dominant cover and 3 times as associated cover.

Use site	Dominant cover frequency (% frequency)	Associated cover frequency[a]	Total
Saw palmetto (*Serenoa repens*)	63 (66)	1	64
Blechenum fern (*Blechenum serrulatum*)	6 (6)	22	28
Cabbage palm (*Sabal palmetto*)	6 (6)	18	24
Limestone solution hole	5 (5)	0	5
Tree root base[b]	5 (5)	0	5
Cypress (*Taxodium distichum*)	3 (3)	11	14
Brazilian pepper (*Schinus terebinthefolius*)	3 (3)	0	3
Sawgrass (*Cladium jamaicense*)	2 (2)	0	2
Leather fern (*Acrosticum danaeifolium*)	1 (1)	0	1
Cinnamon fern (*Osmunda cinnamomea*)	1 (1)	0	1
Live oak (*Quercus virginianus*)	0	28	
Wild grape (*Vitis* spp.)	0	28	
Wild coffee (*Psychotria* spp.)	0	18	
Slash pine (*Pinus elliottii*)	0	17	
Wax myrtle (*Myrica cerifera*)	0	16	
Poison Ivy (*Toxicodendron radicans*)	0	15	
Greenbriar (*Smilax* spp.)	0	14	
Laurel oak (*Quercus laurefolia*)	0	14	
Myrsine (*Myrsine floridana*)	0	13	
Staggerbush (*Lyonia ferruginea*)	0	10	
Marsh fern (*Thelypteris* spp.)	0	10	

[a]Species occurring <10 times as associated cover were red maple (*Acer rubrum*), red bay (*Persea borbonia*), gallberry (*Ilex glabra*), sumac (*Rhus copallina*), American beautyberry (*Callicarpa americana*), bracken (*Ptreidium aquilinum*), Boston fern (*Nephrolepis biserrata*), swamp dogwood (*Cornus foemina*), hog plum (*Ximenia americana*), and wild fig (*Ficus americana*).

[b]Includes: cypress ($N=2$), laurel oak ($N=2$) and pop ash (*Fraxinus caroliniana*).

however, this varied among the females. Panthers No. 11 and No. 19 did not change den-use patterns from the first to second half of the denning period. Females No. 31 and No. 32, however, spent > 70% of the time at the den during the first half and < 40% during the second half of the denning period (Fig. 3). Den arrivals centered around 0800 and departures centered around 2200, although these events could occur at any hour and varied among females. Female activity at den sites peaked immediately before departures and after arrivals.

Ninety-six hourly activity means were obtained for 4 denning female panthers and 90 means were obtained for 5 solitary panthers. Activity means varied by hour ($F = 4.50$; 23, 131 df; $P < 0.0001$), the fit of a sinusoidal regression model with periods of 12 and 24 hours to the least squares means was significant ($F = 19.48$; 23, 131 df; $P < 0.0001$), and lack of fit for the sinusoidal contrast was not significant ($F = 1.35$; 19, 131 df; $P = 0.1638$). These results indicate that hourly mean percent activity for all panthers followed a general cycle of nocturnal activity as well as a shorter cycle of crepuscular activity. Hourly panther activity differed between solitary and denning female panthers ($F = 1.98$; 23, 131 df; $P = 0.0089$). Sinusoidal

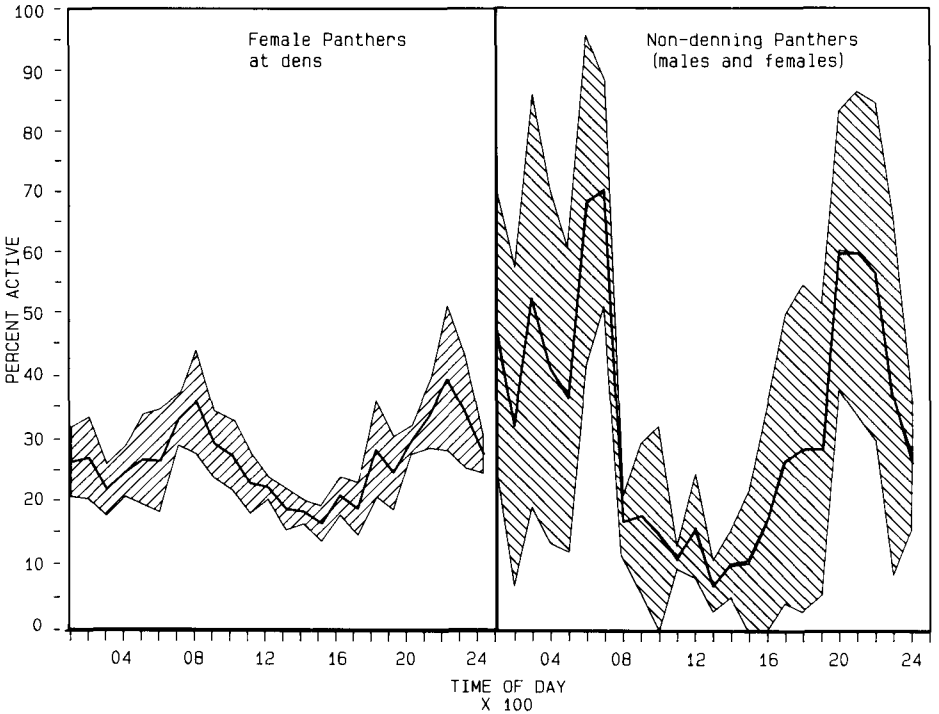

Figure 1. Activity patterns of female Florida panthers at den sites and solitary Florida panthers. Cross-hatching represents 1 standard deviation.

regressions of group least squares means were different ($F = 5.57$; 4, 131 df; $P = 0.0004$), particularly in the cosine components for the 12-hour ($F = 7.53$; 1, 131 df; $P = 0.0069$) and 24-hour ($F = 13.59$; 1, 131 df; $P = 0.0003$) periods. Neither sine component differed between groups ($P > 0.35$). Lack of fit for the sinusoidal contrast was not significant ($F = 1.22$; 19, 131 df; $P = 0.2512$). Amplitudes for both the diurnal and semidiurnal cycles were greater (i.e., more variation) for solitary panthers than for denning females, but the activity cycles remained in phase (Fig. 1).

The high level of saw palmetto use suggests a preference for these areas as day beds. Bothma and Richie (1984) found that leopards (*Panthera pardus*) used dense vegetation, primarily of a single species, in the Kalahai Desert. Upland sites such as palmetto accounted for a greater proportion of habitat used than predicted by availability (75% vs. 27%). In south Florida we encountered 3 growth forms of this clumping species (see illustration in Stevenson 1974:67): low, 1-m clumps with horizontal stems; intermediate, 1- to 3-m clumps with semi-erect stems; tall, 3- to 5-m arborescent clumps with vertical stems. In each case, clumps covered from 0.1 to 2.0 ha. When panthers were found in this vegetation, the height of palmetto usually was 2–3 m. On 7 occasions between April and August, open air temperatures at ground level ranged from 28–42 C ($\bar{x} = 36$C) and day bed air at ground level

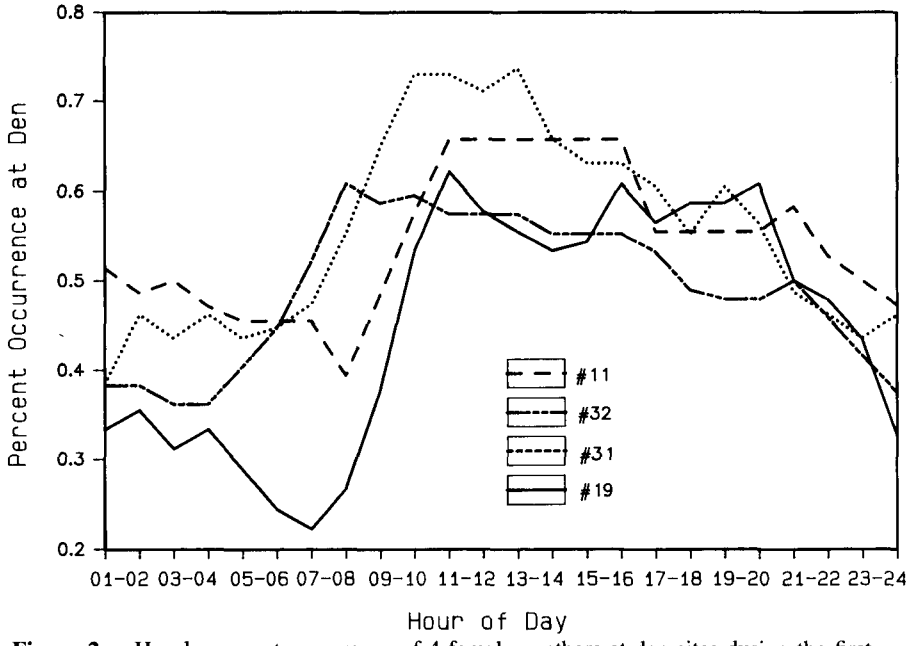

Figure 2. Hourly percent occurrence of 4 female panthers at den sites during the first 7–9 weeks postpartum.

ranged from 27–31 C ($\bar{x}$ = 29 C). On 1 occasion (18 Apr 1988), open air was 39 C and day bed air was 25 C. Ludlow and Sunquist (1987) reported that ocelots (*Felis pardalis*) used dense cover for daybeds that were, on average, 3 C cooler than open air temperature during the dry season. Shorter palmetto probably does not provide vertical cover and cooler temperatures, while taller clumps do not provide the horizontal cover apparently preferred by panthers. Other types of dominant cover in our study were similar to palmetto in providing dense horizontal concealment. We suspect that a combination of relatively cool temperatures (especially during warm months; Apr–Nov) and dense, concealing cover were the most important factors in panther day bed selection.

Dens were maintained for 47–56 days ($\bar{x}$ = 52, n = 6), apparently while kittens were incapable of independent travel. The end of this interval coincides with the cessation of nursing reported for captive mountain lions (Eaton and Velander 1977), and first visits by kittens at kills (Grinnell et al. 1937). Multiple den sites may have resulted from females translocating kittens to escape parasite infestation and early wanderings of kittens at the initial den. Multiple dens were within 50 m of each other.

Den visitation rates of 2 related female pairs varied. Nos. 11 and 19 were a mother-daughter pair. No. 19 had been radio-collared as a dependent kitten), and we suspect that Nos. 31 and 32 were a mother-daughter pair due to their relative

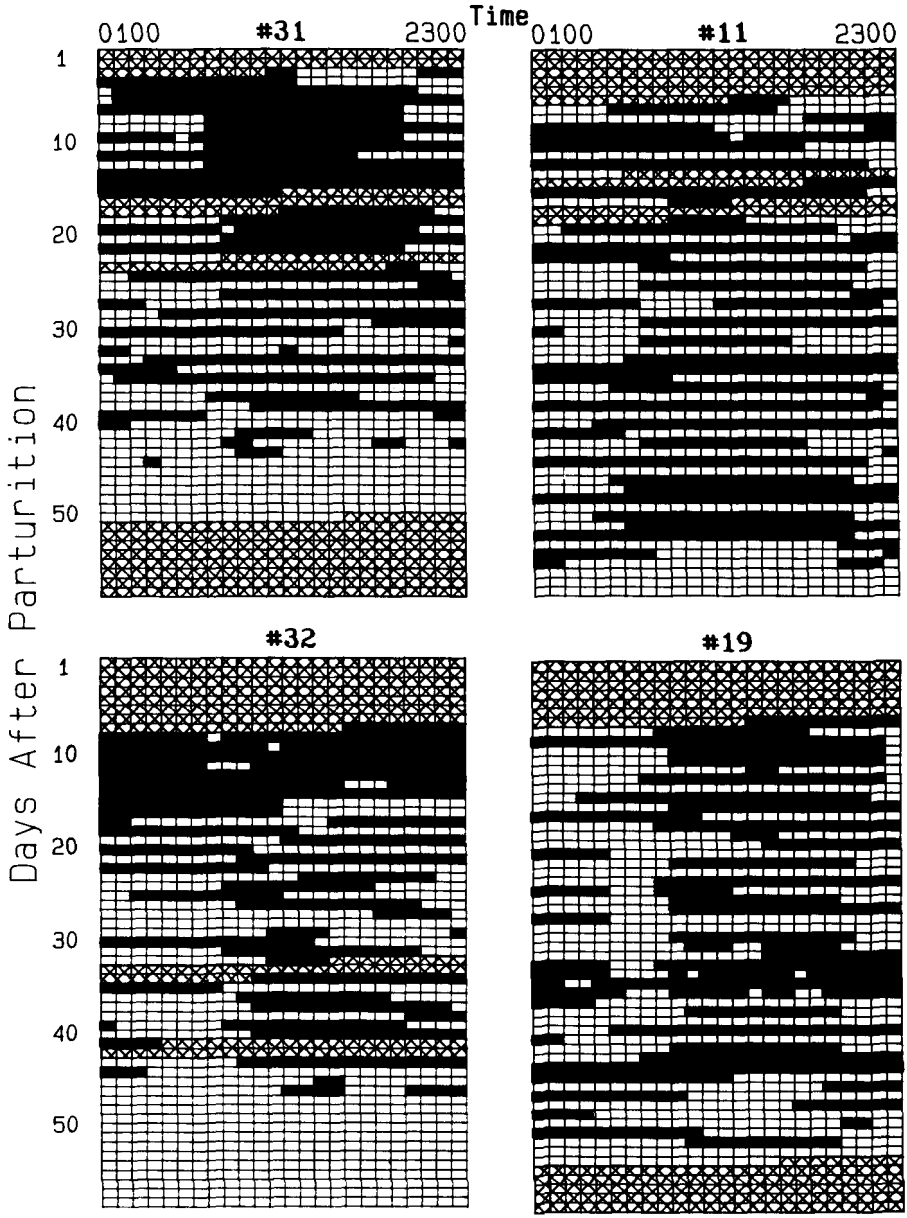

Figure 3. Hourly presence and absence of 4 female Florida panthers at den sites. Solid, blank, and hatched squares represent presence, absence, and no data, respectively.

ages (7–9 and 2–3, respectively) and the high degree of home range overlap between them. No. 19 gave birth to her first litter within No. 11's home range (Maehr et al. 1989*b*), and No. 32 denned for the first time within 8 km of No. 31's den. Den activity profiles were similar within related pairs and different between pairs (Fig. 3). Females 31 and 32 were more likely to be with their kittens during the first half of denning, while females 11 and 19 distributed their attendance more evenly through the denning period. Although prey abundance may influence female panther behavior (Maehr et al. 1989*a*), prey density and physical condition were similar in the areas used by the 4 female panthers (McCown 1990), and, therefore, we assume did not affect the behavior we observed. Other large carnivores such as black bears (*Ursus americanus*, Rogers 1987), tigers (*Panthera tigris*, Smith et al. 1987), and African lions (*P. Leo*, Packer 1986) show a high degree of tolerance or cohesion among females. The pattern we found suggests this also is true for Florida panthers and that some aspects of behavior may be the result of learning or heredity.

Departures from and arrivals at dens of denning females were concentrated during periods of peak activity similar to those illustrated for of solitary panthers in Figure 1. Cooler temperatures around sunrise and sunset and increased activity of prey species during these times (Marchinton and Hirth 1984:140, Sweeney and Sweeney 1982:1105) probably account for this pattern. However, activity of females at dens was lower during evening hours (1700–0800) and higher during daylight (0800–1700) than that of solitary panthers. We suspect that behavior related to kitten care at the den increased activity during times when solitary panthers were normally motionless.

Johnson and Pelton (1983) noted that psychological and habitat imprinting by black bears may influence their adaptability to changing land uses. Panther's selection of day beds and maternal dens may be behaviors based on many centuries of successful reproduction in southwest Florida. Reductions in the availability or quality of these sites, even if prey numbers and foraging habitat are maintained, may have negative influences on panther survival and recovery. It is unknown to what extent panthers can tolerate changes in their environment. However, there are many areas within the subspecies' historical range where prey is abundant yet panthers are absent. The availability of adequate resting and denning cover should be a consideration in maintaining and reestablishing the Florida panther. Reintroduction sites should contain upland cover similar in structure and abundance to day bed and denning habitat observed in southwest Florida.

Literature Cited

Belden, R. C., W. B. Frankenberger, R. T. McBride, and S. T. Schwikert. 1988. Panther habitat use in southern Florida. J. Wildl. Manage. 52:660–663.

Bothma, J. D. and E. A. N. Richie. 1984. Aspects of the ecology and behaviour of the leopard *Panthera pardus* in the Kalahari Desert. Koedoe 27:259–279.

Davis, J. H., Jr. 1943. The natural features of southern Florida, especially the vegetation, and the Everglades. Fla. Geol. Surv. Geol. Bul. 25. 311 pp.

Deuver, M. J., J. E. Carlson, J. F. Meeder, L. C. Deuver, L. H. Gunderson, L. A. Riopelle, T. R. Alexander, R. L. Myers, and D. P. Spangler. 1986. The Big Cypress National Preserve. Res. Rep. 8 Natl. Audubon Soc. New York, N.Y. 444pp.

Eaton, R. L. and K. A. Velander. 1977. Reproduction in the puma: biology, behavior, and ontogeny. World's Cats 3:45–70.

Grinnell, J., J. S. Dixon, and J. M. Linsdale. 1937. Furbearing mammals of California. Univ. Calif. Press, Berkeley, Calif. 777pp.

Hemker, T. P., F. G. Lindzey, and B. B. Ackerman. 1984. Population characteristics and movement patterns of cougars in southern Utah. J. Wildl. Manage. 48:1275–1284.

Johnson, K. G. and M. R. Pelton. 1983. Bedding behavior of black bears in Tennessee. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 37:237–243.

Logan, K. A. and L. L. Irwin. 1985. Mountain lion habitats in the Big Horn Mountains, Wyoming. Wildl. Soc. Bul. 13:257–262.

Ludlow, M. E. and M. E. Sunquist. 1987. Ecology and behavior of ocelots in Venezuela. Nat. Geogr. Res. 3:447–461.

Marchinton, R. L. and D. H. Hirth. 1984. Behavior. Pages 129–168 *in* L. K. Halls ed. White-tailed deer ecology and management. Stackpole Books. Harrisburg, Pa.

Maehr, D. S. 1990. The Florida panther and private lands. Conserv. Biol. 4:167–170.

———, E. D. Land, J. C. Roof, and J. W. McCown. 1989*a*. Early maternal behavior in the Florida panther (*Felis concolor coryi*). Am. Midl. Nat. 122:34–43.

———, J. C. Roof, E. D. Land, and J. W. McCown. 1989*b*. First reproduction of a panther (*Felis concolor coryi*) in southwestern Florida. Mammalia 25:37–38.

McCown, J. W. 1990. Big Cypress deer/panther relationships: deer herd health and reproduction. Annu. Rep. Fla. Game and Fresh Water Fish Comm. Tallahassee, Fla.

———, D. S. Maehr, and J. Roboski, 1990. A portable cushion as a wildlife capture aid. Wildl. Soc. Bul. 18:34–36.

Packer, C. 1986. The ecology of sociality in felids. Pages 429–451 *in* D. I. Rubenstein and R. W. Wrangham, eds. Ecological aspects of social evolution. Princeton Univ. Press. Princeton, N.J.

Rogers, L. L. 1987. Effects of food supply and kinship on social behavior, movements, and population growth of black bears in northeastern Minnesota. Wildl. Monogr. 97:1–72.

Smith, J. L. D., C. W. McDougal, and M. E. Sunquist. 1987. Female land tenure system in tigers. Pages 97–109 *in* R. L. Tilson and U.S. Seal, eds. Tigers of the world. Noyes Publ. Park Ridge, N.J.

Steel, R. G. D. and J. H. Torrie. 1980. Principles and procedures of statistics. Second ed. McGraw-Hill, New York, N.Y. 633pp.

Stevenson, G. B. 1974. Palms of south Florida, George B. Stevenson (distr. by Fairchild Tropical Garden). Miami, Fla. 251pp.

Sweeney, J. M. and J. R. Sweeney. 1982. Feral hog. Pages 1099–1113 *in* J. A. Chapman and G. A. Feldhammer, eds. Wild mammals of North America. Johns Hopkins Univ. Press. Baltimore, Md.

Van Dyke, F. G., R. H. Brocke, H. G. Shaw, B. B. Ackerman, T. P. Hemker, and F. G. Lindzey. 1986. Relations of mountain lions to logging and human activity. J. Wildl. Manage. 50:95–102.